METHOD FOR PRODUCING EXTRUDED OPEN-CELL FOAM PLATES

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Abstract of **WO03018678**
The invention relates to a method for producing open-cell foam plates by extruding a polystyrene melt together with a foaming agent mixture composed of CO2 and water.

We claim:

1. A process for producing foam sheets with an open-cell percentage of more than 80% and an average cell size of more than 100 µm, based on styrene polymers, by extruding a polymer melt in which the styrene polymer is the only polymer present, together with from 2 to 12% by weight, based on the styrene polymer, of a volatile blowing agent, and also with conventional additives, at elevated temperatures, which comprises using a mixture made from CO_2 and water in a weight ratio of from 80:20 to 20:80 as blowing agent.

2. A process as claimed in claim 1, wherein the styrene polymer is polystyrene.

3. The use of the foam sheets produced as claimed in claim 1 for sound-deadening in the construction industry.

Production of extruded open-cell foam sheets

The invention relates to a process for producing open-cell foam sheets by extruding a styrene polymer melt together with a volatile blowing agent.

Open-cell polystyrene foam sheets have excellent suitability for sound-deadening. There are known to be two measures for achieving a good percentage of open cells: increasing the temperature of the polystyrene melt at the extruder die and/or admixing foreign polymers incompatible with polystyrene.

For example, WO 96/00258 describes the production of polystyrene foams with an open-cell percentage of from 30 to 80% by extruding a polystyrene melt together with a volatile blowing agent at a foaming temperature which is higher, by from 3 to 15°C, than the temperature used when producing corresponding closed-cell foams. A wide variety of volatile inorganic or organic compounds may be used as blowing agents, those mentioned including CO_2 and water. Preference is given to mixtures made from CO_2 and ethyl chloride and/or monochlorodifluoroethane. However, halogenated hydrocarbons have the disadvantage of plasticizing polystyrene and not permitting the percentage of open cells to be very high. They can also cause environmental problems.

WO 36/34038 describes extruded open-cell polystyrene foams with an average cell size of not more than 70 µm. These can be evacuated and used as a vacuum-insulation material. The blowing agents used here are once again the same as those used in the abovementioned publication. However, microcellular foams of this type exhibit poor sound absorption.

WO 98/58991 and WO 99/47592 describe the production of open-cell polystyrene foams by foam extrusion from mixtures of polystyrene with ethylene polymers, the abovementioned blowing agents again being used.

According to DE-A 100 05 873, cell-opening is brought about by adding polymethyl methacrylate to polystyrene. However, the admixing of foreign polymers affects the mechanical properties of the foams – mostly adversely.

It is an object of the present invention, therefore, to provide a process which can produce open-cell polystyrene foam sheets with excellent sound absorption and good mechanical properties, and

which can be used without any addition of foreign polymers to the styrene polymer.

We have found that this object is achieved in that when a blowing agent mixture made from CO_2 and water is used, the water likewise opens the cells, and no addition of foreign polymers is therefore needed.

The invention therefore provides a process for producing foam sheets with an open-cell percentage of more than 80% and an average cell size of more than 100 µm, based on styrene polymers, by extruding a polymer melt in which the styrene polymer is the only polymer present, together with from 2 to 12% by weight, based on the styrene polymer, of a blowing agent mixture made from CO_2 and water in a ratio by weight of from 80:20 to 20:80, at elevated temperatures.

For the purposes of the present invention, styrene polymers are polystyrene and copolymers of styrene which contain at least 80% by weight of styrene incorporated into the polymer. Examples of comonomers which may be used are α-methylstyrene, ring-halogenated styrenes, ring-alkylated styrenes, acrylonitrile, (meth)acrylic esters of alcohols having from 1 to 8 carbon atoms, N-vinyl compounds, such as vinylcarbazole, maleic anhydride, and also small amounts of compounds which contain two polymerizable double bonds, such as butadiene, divinylbenzene, or butanediol diacrylate. Polystyrene is preferred.

The foam sheets of the invention preferably have a thickness of more than 15 mm, in particular from 20 to 100 mm. Their cross-sectional area is preferably from 100 to 1000 cm^2. The density of the foam sheets is preferably from 20 to 100 $g \cdot l^{-1}$. According to the invention, they have an open-cell percentage of more than 80%, preferably more than 90%, and in particular at least 95%, measured to DIN ISO 4590.

The average cell size is preferably more than 100 µm, with preference from 120 to 500 µm. If the percentage of open cells is too small or the cell size is too small, the foam sheets have less capability for absorbing sound.

The foam sheets are produced in a manner known per se, by extrusion. The thermoplastic matrix plastified by heating is intimately mixed, in an extruder, with the blowing agent or blowing agent mixture and, where appropriate, other additives. The mixture then passes through a relaxation zone in which it is

cooled, with constant agitation, to about 125-140°C, and then passes through a die to give sheets.

The temperature of the melt at the die here should be higher, by from about 5 to 15°C, than when producing corresponding closed-cell foam sheets.

The usual amounts of stabilizers, dyes, fillers, flame retardants, and/or nucleating agents may be added to the thermoplastic matrix, these being conventional additives and/or auxiliaries. Preference is given to 1-10% by weight, based on the styrene polymer, of an infrared absorber, e.g. carbon particles, in particular graphite powder, the result being a further increase in the proportion of open cells.

According to the invention, the blowing agent used comprises a mixture made from CO_2 and water in a weight ratio of from 80:20 to 20:80, preferably from 70:30 to 40:60, the amount used being from 2 to 12% by weight, in particular from 3 to 8% by weight, based on the styrene polymer.

The foam sheets produced according to the invention are particularly advantageously used for sound-deadening in the construction industry. However, they may also be used for thermal insulation or for producing vacuum panels.

Example:

The foam specimens were extruded on a tandem plant. This was composed of a melting extruder and a cooling extruder. Polystyrene (MW 240 000) was fed to the first extruder together with 1% of graphite (grade UF2 96-97; average particle size 4 µm; from Graphitwerk Kropfmühl, Germany). The polymer was melted and a blowing agent mixture made from 2% of CO_2 and 1.8% of water, in each case based on polystyrene, was injected and then mixed into the melt. The melt comprising blowing agent was then cooled in the second extruder to the temperature of 133°C needed for the foaming process. Once the melt had emerged from a sheet die it foamed and was molded in a calibrator to give sheets.

The resultant sheet (density 39 g/l, open-cell percentage 95%, average cell size 150 µm) was sawn through its center, and sound absorption to DIN 52215 was measured on the rough sawn side.

The table below shows the sound absorption values measured:

Frequency (Hz)	Degree of sound absorption (%)
800	19.7
1000	28.8
1250	39.1
1600	50.0
2000	60.5
2500	69.4
3150	75.9
4000	79.9

Production of extruded open-cell foam sheets

Abstract

The invention relates to a process for producing open-cell foam sheets by extruding a polystyrene melt together with a blowing agent mixture made from CO_2 and water.